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# Common attitudes about concomitant vaccine injections for infants and adolescents in Flanders, Belgium

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ABSTRACT

Quantitative information on parents' preferences regarding multiple vaccine injections and on work-loss due to vaccination is important to guide decision making on the use of combination vaccines for universal vaccination. Our survey in families of 1347 toddlers (18–24 months) and 1315 adolescents residing in Flanders, Belgium, revealed common attitudes in both age groups. The majority of parents would allow maximum two injections in one visit. 39% were not willing to pay anything to avoid a concomitant injection, whereas the remainder mentioned amounts around a median of €20. The responses were hardly influenced by the socioeconomic determinants studied and the concordance between the number of concomitant injections parents would allow and their willingness-to-pay assessed by an open-ended question was limited, which suggests that more sensitive quantification using other methods would be useful. Work-loss due to vaccination was assessed for infants only and was rare (4.5%).


## 1. Introduction

With the rising number of vaccines, health care providers are increasingly concerned about the number of injections building up rapidly in infants and adolescents, despite the tempering effect of more extensive new combination vaccines. In Belgium, the so-called "pin-cushion-syndrome" has hitherto been softened by incorporating multivalent combination vaccines in routine vaccination practices in a timely manner. These vaccines can be obtained free of charge from preventive care services (Well Baby Clinics and School Health Services) that offer other free services as well, and in private practices of paediatricians and family physicians, according to the parents' preference. However, in order to include all currently recommended vaccines in the existing five recommended vaccination visits between the ages of 2 and 15 months, concomitant vaccine injections have become inevitable in nearly all visits [1]. Yet more additions (e.g. human papilloma, influenza and varicella-zoster virus vaccines) are to be expected over the next 5 years. Some of these are likely to be given during pre-adolescence. Obviously, if they could be administered jointly with other routine vaccines, e.g. the catch-up measles-mumps-rubella (MMR) dose (currently at age 10–12 years), it would be easier to achieve higher vaccination coverage [2]. This way, the "pin-cushion-syndrome" is likely to start affecting older age groups too.

If concomitant administration is experienced as harmful or very discomforting for the child, this could be one of the reasons why parents are more likely to refuse a vaccine or demand a delay, which enhances the risk of incomplete vaccination [3]. The only way to limit the number of concomitant injections without increasing the number of visits is to use new combination vaccines. However, those are usually introduced at a higher price than the sum of their separate components. In order to assess the desirability of using such combination vaccines by economic evaluation, it is important to try and elicit information on parental attitudes and willingness-to-pay (WTP) for a reduction in the number of injections per visit [4]. Up till now, few studies sought to research this WTP (three to our knowledge, all in parents of infants in the US) [5–7]. Clearly these issues are of general interest, and are by no means restricted to Belgium.

Our study aimed to gain insight into parents' attitudes regarding concomitant injections for their children, parental work-loss due to vaccination, and WTP to avoid a concomitant injection. In the current paper we compare for the first time attitudes of parents of infants with those of adolescents, in a large representative sample.

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## 2. Methods

### 2.1. Survey design

This study is complementary to a vaccination coverage survey which was described in detail before [1,8]. Briefly, a two-stage cluster sample of 1500 infants aged 18–24 months and 1500 adolescents aged 14 years were visited at home between May and July 2005. The sample size was determined based on the expected vaccine coverage rates. Only children officially registered as resident in Flanders were included, after written informed consent. Participants were excluded and replaced when they could not be contacted after three attempts or in case of serious language problems. Adolescent participants additionally had to attend the first year of secondary school (usually at age 12–13 years) to be included. Families who explicitly refused to participate were not replaced to avoid exchanging parents opposing vaccination with parents favoring vaccination. For the current study, only data from children whose parents or grandparents had been interviewed were taken into account, because we considered the opinion of less closely related responders to be less relevant. The survey was approved by the Antwerp University Hospital Ethics Committee and by the Belgian Privacy Commission [1,8].

### 2.2. Main outcome measures

To estimate the indirect cost of a concomitant injection, an open-ended willingness-to-pay question (Q1) was asked (similar as in [6]): "[translated] Imagine: Your child received several injections during one visit. If your child would enjoy the same protection receiving one injection less during the same visit, e.g. one instead of two injections, what would be the maximal amount (Euro) you would be willing to pay, to spare your child one injection?" The answer was limited to 4 digits, which allowed a range from €0 to €9999.

To assess the parent's attitude regarding multiple injections, the following question (Q2) was used: "[translated] What is the maximum number of injections you would allow to be given to your child during one visit?" Any number, including 0, or "unlimited" could be answered. Q1 and Q2 were part of the infant as well as adolescent questionnaire.

For parents of infants, an additional question (Q3) was asked to assess potential work-loss due to vaccinations: "[translated] Did anyone have to take absence from work for the vaccination of your child?" In case of an affirmative answer, details were requested about who missed work, and for how long (measured in half work days, recalculated here in workdays). As outlined above, in order to complete the recommended Belgian infant vaccination schedule at least five vaccination visits are needed during a period of 16–20 months.

### 2.3. Other measures

A variety of socio-demographic and other characteristics were collected during the interview [1,8], a selection of which was used for this study to avoid multicollinearity problems (see Table 1). Parental ethnicity was categorised as non-Belgian if a parent or grandparent was born outside Belgium and as non-European if a parent or grandparent was born outside the European Union (based on the 25 member states at the time of the study). The monthly household income was defined as the total amount of disposable income including wages, alimony and social security allowances. General information on the main vaccinating physician was available for the infants' analyses, but not for the adolescents. The vaccination status of the infant or adolescent was copied from vaccination documents and supplemented by information from the vaccinating physician. In infants, doses were not counted as part of the administered doses if they had been given too early compared to the National Health Council's guidelines (as described in [1]). Adolescents were categorised as completely vaccinated if they had received at least three doses of hepatitis B (HBV) vaccine, one dose of meningococcal serogroup C (MenC) vaccine and the MMR dose scheduled at 10–12 years of age [8]. Since only minor deviations from a valid vaccination scheme were noted, no doses were excluded for validity concerns in adolescents. Because the number of children receiving no vaccine at all was rather low (1% of toddlers and 7.1% of adolescents), they were categorised with the not completely vaccinated [1,8].

**Table 1**
Characteristics of the respondent families, frequencies (in %) per age group.

| Characteristic | Infants $N = 1347$ | Adolescents $N = 1315$ |
|---|---|---|
| Mother's education | | |
| Lower than secondary school or vocational training | 19 | 29 |
| Secondary school | 31 | 35 |
| Higher education | 50 | 36 |
| Father's education | | |
| Lower than secondary school or vocational training | 21 | 31 |
| Secondary school | 36 | 35 |
| Higher education | 43 | 34 |
| Mother's employment situation | | |
| Full-time salaried | 39 | 29 |
| Free-lance or not full-time | 33 | 44 |
| Not working | 28 | 27 |
| Father's employment situation | | |
| Full-time salaried | 79 | 77 |
| Free-lance or not full-time | 15 | 17 |
| Not working | 6 | 6 |
| Mother's ethnicity | | |
| Belgian | 81 | 87 |
| Other country in European Union | 7 | 6 |
| Non-European | 12 | 7 |
| Father's ethnicity | | |
| Belgian | 82 | 87 |
| Other country in European Union | 6 | 6 |
| Non-European | 12 | 7 |
| Monthly household income | | |
| Lower than €1500 | 8 | 10 |
| €1500–3000 | 46 | 42 |
| Higher than €3000 | 25 | 22 |
| Unknown | 21 | 26 |
| Number of children | | |
| Only one | 37 | 15 |
| Two | 42 | 44 |
| Three or more | 21 | 41 |
| Child selected for the survey was completely vaccinated | 75 | 64 |

### 2.4. Statistical analysis

We used descriptive and explorative statistical methods, including histograms, scatter plots with lowess smoother and regression modelling [9,10] to evaluate whether responses on Q1, Q2 and Q3 could be predicted by the other characteristics outlined above. Also the answer on Q1 was evaluated as a predictor for the answer on Q2, and vice versa. Separate regression models were built for each age group, and various techniques were used for the other dependent variables. WTP amounts were explored using linear regression; the maximal number of concomitant injections parents would allow was evaluated by Poisson regression. Additionally, answers were

recoded into response categories to be able to include non-numeric answers, i.e. "nothing", "a specified amount" and "an unlimited amount" for Q1, and "a specified number" and "unlimited number" for Q2. These response categories were compared using logistic regression. In all analyses, the survey design was taken into account. Variables were omitted by backward selection, based on the level of significance. An association was considered non-significant and the corresponding variable dropped if the *p*-value was equal to or exceeded 0.05, except for borderline non-significant associations that were considered indicative. All analyses were performed using Stata 9 (StataCorp LP) software.

## 3. Results

### 3.1. Study population

Of the originally intended sample of 1500 families of infants aged 18–24 months and 1500 adolescents aged 14 years, 1476 and 1495, respectively, were reached at home but 117 and 137, respectively, refused to participate, mainly due to lack of interest and/or time. The questionnaires from 5 infants and 14 adolescents were lost between interview and analysis [1,8]. Additionally, data from 2 infants and 29 adolescents were excluded because the responder was not a parent or grandparent.

The collected socio-demographics of the children and their families were comparable to census data on Flemish children under three years of age and adolescents in the first grade of secondary school, except for the gender distribution in infants which was slightly disproportional to a varying degree in the different provinces [1,8]. Therefore, weighting for gender with post-stratification for province was applied to the infant data, necessitating the exclusion of five more infants [1]. Finally, data from 1347 infant and 1315 adolescent questionnaires were used for analysis.

The respondents were mainly mothers (79% in the infant and 80% in the adolescent sample) with mean age 29 (infants) and 42 years (adolescents); grandparents accounted for less than 2% of respondents. Determinants included in the analysis are the characteristics of the interviewed families as summarized in Table 1, the responder type and the main vaccinator (in infants only) which was a physician in a Well Baby Clinic (81%) or day-care center (2%), a family physician (5%) or a paediatrician (11%).

Less than 5% of data were missing along all recorded variables, except for household income, which remained unknown for 21% of infant and 26% of adolescent families. In order to account for missing data on income, this variable was recoded into a two-level variable with a first level indicating whether or not income was specified, and conditional on this, a second level indicating the income on an ordinal scale. But inclusion of this two-level variable resulted in multicollinearity, therefore we only retained the variable indicating whether or not income was specified (and thus known) by the respondent.

### 3.2. Results for Q1: willingness-to-pay to avoid a concomitant injection

A total of 1231 (91%) families of infants and 1168 (89%) families of adolescents answered upon the WTP question. Families who did not reply were also more likely not to state their income, and for infants, they were more often of non-European origin. Note that, for infants only, brief summary of the responses to this question was reported elsewhere [11].

In both age groups the amount mentioned varied between €0 and €1000 with median €5 and interquartile range €0–20, the mean was €15.7 in infants and €13.9 in adolescents. Amounts of

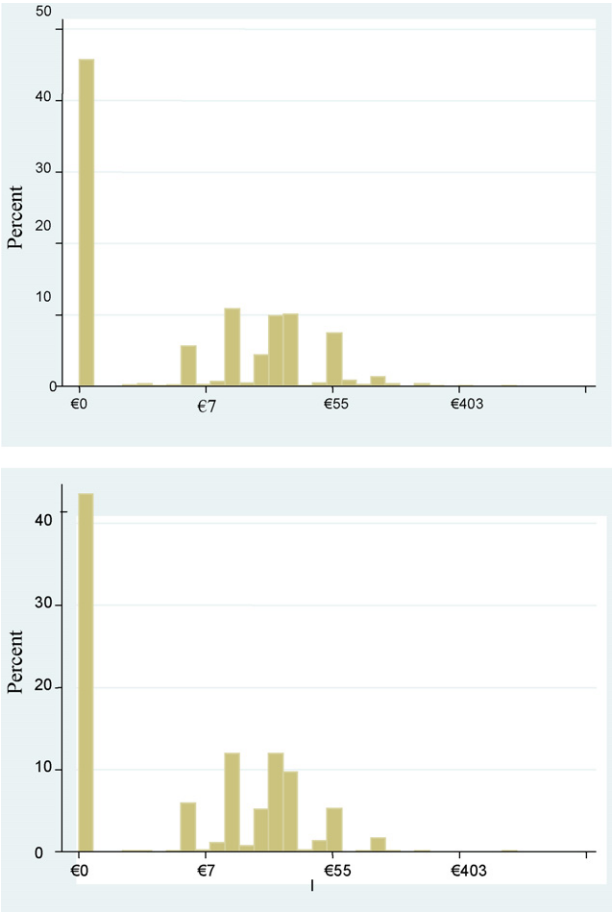


**Fig. 1.** Amount parents are willing to pay to avoid a concomitant injection, on a logarithmic scale, for parents of infants (upper panel) and of adolescents (lower panel).

€250 or higher were mentioned in only 4 infant and 2 adolescent families, while 550 (41.0%) infant and 510 (38.8%) adolescent families answered "0€". Fig. 1 demonstrates the existence of two major subgroups, i.e. one not willing to pay anything (subgroup 1), and one willing to pay a certain amount (subgroup 2), with median €20 in both age categories and mean €30.0 infants and €24.6 in adolescents. Furthermore, a small subgroup of 29 (2.1%) infant and 7 (0.5%) adolescent families answered they would pay whatever it takes (subgroup 3).

Logistic regression compared the different subgroups of parents (summarized in Table 2). Parents of infants were less frequently in subgroup 2 if they did not state their income, whereas mothers with secondary school as highest level of education were more frequently in subgroup 2 (Model 1 in Table 2). Parents of adolescents were more frequently in subgroup 2 if they allowed more concomitant injections and less frequently if the father was not working (Model 3). Parents of infants in subgroup 3 were also compared to other categories, but this did not provide any additional insights.

Within subgroup 2, linear regression found that mothers of infants originating from another European country were willing to pay higher amounts, as well as mothers who mainly consulted a paediatrician for vaccination of their infant (Model 2). Working mothers of adolescents were willing to pay more than non-working mothers (Model 4).

The linear regression models in Table 2 explained 2.4% of the variation in responses for infants, and 0.8% for adolescents, as determined by the regression *R*-squared.

**Table 2**
Predictors for willingness-to-pay to avoid a concomitant injection, in parents of infants (upper part) and adolescents (lower part) in Flanders.

| | OR | 95% CI |
|---|---|---|
| For infants | | |
| *Being willing to pay a certain amount versus nothing (Model 1, logistic regression)* | | |
| Income unknown (versus known income) | 0.61* | 0.41–0.90 |
| Mother's education (versus lower than secondary school) | | |
| Secondary school | 1.58* | 1.11–2.29 |
| High school or university | 1.12 | 0.81–1.54 |
| Father's employment situation (versus full-time salaried) | | |
| Not full-time or free-lance | 0.69* | 0.51–0.92 |
| Not working | 0.68 | 0.43–1.08 |
| *Amount parents are willing to pay (Model 2, linear regression)* | | |
| Mother's ethnicity (versus Belgian) | | |
| Other EU country | 1.30* | 1.06–1.60 |
| Non-EU country | 1.12 | 0.88–1.43 |
| Main vaccinator (versus Well Baby Clinic) | | |
| No main vaccinator (child not vaccinated) | 1.05 | 0.70–1.60 |
| Family physician | 1.09 | 0.86–1.39 |
| Paediatrician | 1.25* | 1.05–1.48 |
| Doctor in day-care | 0.73 | 0.42–1.26 |
| For adolescents | | |
| *Being willing to pay a certain amount versus nothing (Model 3, logistic regression)* | | |
| Maximum number of injections allowed during one visit | 1.28* | 1.05–1.57 |
| Father's employment situation (versus full-time salaried) | | |
| Not full-time or free-lance | 0.83 | 0.58–1.16 |
| Not working | 0.54** | 0.36–0.82 |
| *Amount caregivers of adolescents are willing to pay (Model 4, linear regression)* | | |
| Mother not working (versus working) | 0.86° | 0.06–21.12 |

OR = odds ratio, significant with °$p < 0.1$, *$p < 0.05$, **$p < 0.01$; the characteristic has a negative predictive effect if OR < 1 and a positive predictive effect if OR > 1, 95% CI = 95% confidence interval. Only characteristics with at least one significant ($p < 0.05$) or borderline significant category were mentioned in the table; for the father's employment situation the category "no father" was never indicated.

### 3.3. Q2: maximum number of injections parents would allow during one visit

This question was answered by 1339 (99.4%) of infant families and 1296 (98.5%) of adolescent families. In both age groups a maximum of two injections was mentioned most frequently and less than 20% of parents would allow more. Parents of adolescents were more likely to prefer only one injection compared to parents of infants (Table 3).

In the infant age group, different Poisson regression models were made for parents mentioning a maximum number and for those that would allow an unlimited number of injections. The first subgroup (Model 5 in Table 4) would allow fewer injections if the mother originated from a non-EU country. Borderline significant predictors were the choice of main vaccinator and the number of siblings squared, which suggests a parabolic relationship, visualised in Fig. 2: only for infants with more than two siblings fewer injections would be allowed. Grandparents were more likely to allow an unlimited number of injections than parents, and for completely vaccinated infants an unlimited number of injections would less likely be allowed (Model 6 in Table 4).

In an attempt to compare the responses to Q2 with observed behaviour registered in the coverage survey, we calculated the proportion of infants receiving MMR and MenC on the same date while their parents stated they would tolerate only one injection per visit. This proportion was 65% (153/237).

In parents of adolescents, Poisson regression was not found to be informative. Therefore, these responses were dichotomised (i.e. respondents were divided in two groups, one that would allow two injections, and one that would not). Logistic regression (Model 7 in Table 4) revealed that respondents were more likely to allow more than two injections if the adolescent was completely vaccinated.

### 3.4. Q3: work-loss (in families of infants)

The question that evaluated any work-loss for any recommended vaccination in the first 18–24 months of life remained unanswered in 18 (1.3%) families. In 60 (4.5%) families at least one person missed work for vaccination of the child. Among these, 32 (60%) mentioned the mother, 11 (18%) the father, 3 (5%) both, and 3 (5%) other family members.

The number of lost working days varied from 0.5 to 10 and had a skewed distribution, with a mean of 1.5 (median 1, interquartile range 0.5–1.5). In the four families that mentioned 3.5 or more lost days, non-recommended supplementary vaccinations had been given or the mother had a profession with irregular working hours. Within the entire study population, which comprised 34% of families with both parents working full-time and another 35% with both

**Table 3**
Maximum number of injections parents would allow during one visit.

| Number of injections | Frequency in infants | % | Frequency in adolescents | % |
|---|---|---|---|---|
| 0 | 1 | 0.0 | 1 | 0.0 |
| 1 | 237 | 17.7 | 394 | 30.4 |
| 2 | 910 | 68.0 | 664 | 51.2 |
| 3 | 117 | 8.7 | 122 | 9.4 |
| 4 or more | 8 | 0.6 | 4 | 0.3 |
| Unlimited | 66 | 5.0 | 111 | 8.7 |

Not answered: 8 in infants, 19 in adolescents.

**Table 4**
Predictors for the maximum number of concomitant injections allowed during one visit, in parents of infants (upper part) and adolescents (lower part) in Flanders.

| | OR | 95% CI |
|---|---|---|
| For infants | | |
| *Maximum number of concomitant injections allowed (Model 5, Poisson regression)* | | |
| Mother's ethnicity (versus Belgian) | | |
| Other EU country | 0.95 | 0.87–1.04 |
| Non-EU country | 0.87*** | 0.82–0.93 |
| Number of siblings | 1.02 | 0.98–1.06 |
| Number of siblings squared | 0.99◦ | 0.98–1.00 |
| Main vaccinator (versus Well Baby Clinic) | | |
| No main vaccinator (child not vaccinated) | 0.87 | 0.74–1.02 |
| Family physician | 0.90◦ | 0.82–1.00 |
| Paediatrician | 0.95 | 0.90–1.00 |
| Doctor in day-care | 0.94 | 0.88–1.02 |
| Not willing to pay anything to avoid a concomitant injection | 1.27**[a] | 1.06–1.54 |
| Log of amount willing to pay to avoid a concomitant injection | 1.21**[a] | 1.08–1.36 |
| Square log of amount willing to pay to avoid a concomitant injection | 0.96***[a] | 0.94–0.98 |
| *Allowing an unlimited number of injections (Model 6, Poisson regression)* | | |
| Respondent's relation to the infant (versus mother) | | |
| Father | 1.62 | 0.85–3.03 |
| Grandparent | 4.26* | 1.46–12.55 |
| Infant was completely vaccinated | 0.62◦ | 0.38–1.00 |
| For adolescents | | |
| *Allowing more than 2 injections in a same visit (Model 7, logistic regression)* | | |
| Adolescent was completely vaccinated | 1.65* | 1.06–2.59 |
| Father's employment situation (versus full-time salaried) | | |
| Not full-time or free-lance | 0.90 | 0.49–1.65 |
| Not working | 1.73◦ | 0.55–3.19 |

OR = odds ratio, significant with ◦$p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; the characteristic has a negative predictive effect if OR < 1 and a positive predictive effect if OR > 1, 95% CI = 95% confidence interval. Only characteristics with at least one significant ($p < 0.05$) or borderline significant category were mentioned in the table; the category "no father" in characteristics referring to the father was not mentioned.

[a] If the two largest amounts were excluded, these variables were not significant anymore in Model 5, but the other parameter estimates were not affected if these variables were omitted from the model.

parents working but not both full-time, a total of 73 working days were lost. Regression analysis revealed no significant predictors.

## 4. Discussion

From the results we highlight three important findings. First, parents of infants and parents of adolescents replied similarly to both questions about concomitant administration of vaccines. The distribution of the amounts they were willing to pay was remarkably similar, and the majority of parents would allow maximum two injections during a single vaccination visit. The observation that respondents can be divided into three basic groups with regards to their willingness-to-pay, i.e. nothing, a median of €20, "whatever it takes", has not received much attention before.

The concordance between WTP and the maximum number of injections parents would tolerate was rather limited, as well as the number of significant associations with other variables. Finally, work-loss due to infant vaccination turned out to be very low, at about one workday per 20 infants.

The last finding is not surprising, as in Flanders "Well Baby Clinics" and private physicians are well spread over the country, and consultation hours extend to the evening and the Saturday. The other findings merit further discussion.

The number of injections parents would allow could not predict their WTP and vice versa in infants, and parents of adolescents that tolerated more injections were even more frequently willing to pay something. This could be due to the interpretation of the questions. Parents were not used to pay for recommended vaccines, and an open-ended question (without bidding algorithm) forces the respondent to make a complicated trade-off. The proportion of parents not willing to pay anything was also much higher than reported earlier in parents of infants in the US (11%) [7]. Together with indications of digit preference, and with the occurrence of some implausibly high amounts (€1000) it draws attention to the potential invalidity of using the open-ended WTP technique as such.

The number of concomitant injections most parents would allow concurs with real practice. In Flanders after infancy no concomitant injections are necessary to complete the recommended schedule, which may be reflected in the higher proportion of parents of adolescents allowing only one injection compared to parents of infants. We found that for two-thirds of infants who received MMR and MenC concomitantly, the parents stated that they would allow a maximum of only one injection per visit. This apparent contradiction might be explained by the routine nature of the immunization handlings having a reassuring impact on these parents leading them to consent with more than one injection.

Only a limited number of associations were found significant, mostly in the expected direction: non-working mothers were not willing to pay as much as working mothers and parents consulting a paediatrician for vaccination instead of using free public services were willing to pay more to avoid a concomitant injection. The finding that parents of infants allowed fewer concomitant injections the more siblings their child had could be an effect of experience. And parents consulting Well Baby Clinics for vaccination may be willing to allow more injections per visit, simply because in Well Baby Clinics the number of planned visits per child is limited. In US studies, family income, child's birth order and respondent's education were found predictive for WTP amounts in parents of infants in the context of avoiding concomitant injections, as well as younger age of the infant, parental age, number of shots at the previous visit, and whether the child was from a single parent family [5,7]. Of these, only Kupperman et al. reported the *R*-squared (at 17% still rather low), without specifying the regression method [5]. It seems clear that undeterminable or other characteristics that were not evaluated would be responsible for the variability of parents' responses.

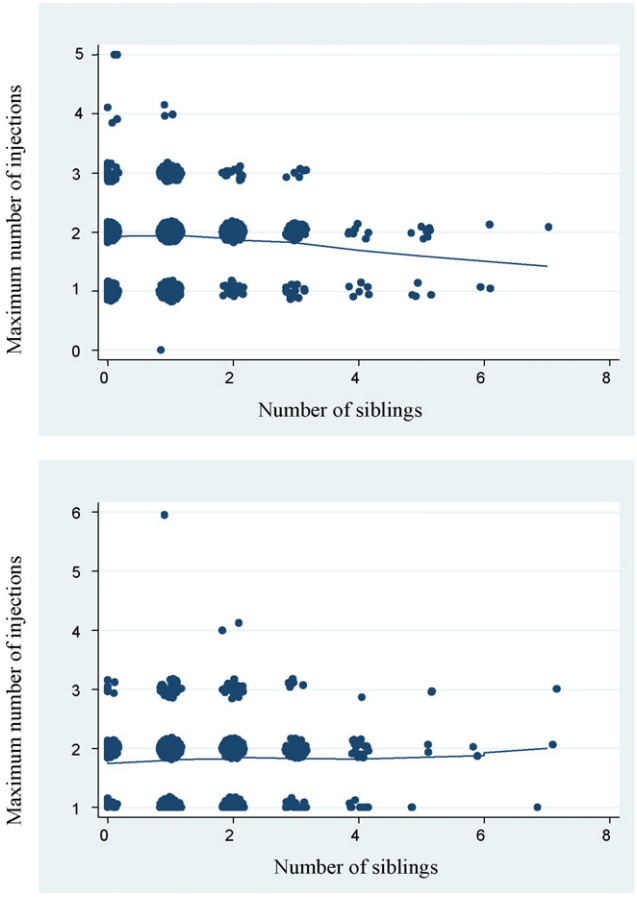


**Fig. 2.** Relation between the maximum number of injections allowed during one visit (Q2) and the number of siblings, in parents of infants (upper) and of adolescents (lower).

A major strength of this study was that it was performed based on a face-to-face interview at home in a large representative sample of families in which children had been recently vaccinated. Bias due to refusal to participate cannot be excluded, though no indications of a link between refusal and attitudes on vaccination were found [1]. A limitation for the regression analysis in infants was that a post-stratification procedure had to be performed as part of the gender weighting, which inevitably affected the parameter estimates and standard errors.

It is important to be aware of parents' preferences regarding concomitant vaccine injections in order to guide decision making on the use of combination vaccines for universal vaccination programs. This study indicated that parents of infants and adolescents in Belgium share common attitudes on the number of concomitant injections they would allow and the value they attribute to avoiding them. But this value varied substantially in both age groups and a thorough analysis yielded little information on what causes that variability. These findings illustrate once again that more sensitive quantification using other more time-consuming methods (e.g. discrete choice experiments [12,13]) would be more insightful.

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